The H*Wind Real-time Hurricane Wind Analysis System

2nd Quarter Report to the Joint Hurricane Transition Center, 2/15/2002

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Executive Summary

Development is on track and H*Wind is well on its way to becoming a valuable operational tool. H*Wind's legacy is as a research and quasi-operational real-time wind analysis system. While we have a very good understanding of needed improvements based on two seasons of testing by research scientists in an operational environment; this is no substitute for extensive testing by its potential operational users. In the second quarter of this JHT effort, feedback was received on our first quarter report (attached to the end of this report) and H*Wind's development team focused on optimizing data flow and identifying additional areas of improvement. As a part of our exchange of ideas with NHC we requested a prioritized list of necessary improvements (to be identified once both hurricane specialists have had a chance to do at least 10-15 real-time/retrospective analyses (Oct. 31 milestone)). This list is needed to provide precise requirements based on extensive user's experience with the software. We have offered to assist with any additional training that might be needed to help accomplish this task. We will be meeting with NHC on 25 Feb. to discuss our second quarter work and plans for the 2002 hurricane season.

Second Quarter Progress

1. Optimize data flow milestone (1 February 2002)

Following the time line agreed to on 9-19-2001, there is only one specified milestone for the second quarter. Tasks associated with this milestone are discussed below:

-As discussed in our first quarter progress report discussing data flow issues, HRD scientists using H*Wind for real-time wind analysis during the 2001 season noticed that more information could be gathered to help define gale force wind radii if the incoming or outgoing recon aircraft maintained their on station altitude until they were beyond the NHC gale force wind radius for the relevant inbound or exit quadrant. After bringing this item to the attention of NHC and discussion among the hurricane specialists, there will now be requests for additional GPS sonde launches to help define the various wind radii during inbound and exit legs for the new and old recon aircraft respectively. An NHOP information item is on the agenda for discussion at the IHC in New Orleans March 11-15. Additional data flow issues associated with reconnaissance aircraft observations should be remedied once the new J model aircraft become available.

- Nick Carrasco has been working on cleaning/improving the data collection scripts, updating decoders to take advantage of better programming techniques as well as to uniform them so that others may look at them and work with them with "ease". Along this process, he is documenting everything involved in data collection and any processing conducted to make the observations conform to the standardized framework defined in Powell et al 1996 (10 m level, max 1 min sustained wind speed for marine exposure or open terrain over land).

- Nick Carrasco and Russell St. Fleur worked on inserting measurement height, pressure, max wind speed for all storm center fixes used in the H*Wind storm track monitoring window, this is especially helpful for the fixes derived from the recon vortex messages.

- Collection of GOES near IR or "short wave" cloud track winds data. This is an outgrowth Jason Dunion's research at HRD in cooperation with NESDIS and Chris Velden's group at University of Wisconsin/CIMSS.

-Collection of QuikScat Sea Winds observations. This is also supported by NESDIS in cooperation with Dr. Paul Chang. This summer a visiting graduate student from Ohio State University will assist us with implementing some new storm center based wind direction dealiasing methods into H*Wind.

2. Tasks in other areas:

- Automatic H*Wind annotation: This is a very important task that will help save time in delivering a wind analysis product. Current products require the analyst to annotate the analysis with a graphics software package. Automating this process will provide useful information on the types of observations used in an analysis, together with other important data on the central pressure, storm motion, location of maximum winds, storm name, date and time, etc. Russell St. Fleur is working on this task which involves the use of Perl scripts and the UNIX GIMP application. This script when called will take the regular output given by H*Wind and using GIMP will edit it to include some text seen on our regular products; such as StormName, Platform measurements are taken from, etc. These extra features help meteorologist determine under what conditions data was taken, the validity of its source, etc. GIMP is the GNU Image Manipulation Program. GIMP is a freely distributed piece of software suitable for such tasks requiring photo editing and retouching, image composition and image authoring. Already in progress; expected to be ready for this season (June 2002 milestone).

* Quality Control (QC) Client (this is the part of the application that allows the scientist to graphically interact with the wind observations):

- Decreased the amount of QCClient's memory usage by an average of 20MB. Now, an average session takes around 50MB of memory. Eliminated a couple of places where heavy memory allocation was unnecessary.

- Sorted event, QCSet and user listings for more clarity. A QCSet is the database-stored collection of observations that were the basis for a wind analysis associated

with a user. The ability to "call up" the data from a past analysis is especially helpful for assembling post storm reports and monitoring analyst performance. Events and QCSets are listed in reverse chronological order and users are listed in alphabetical order.

- Added Pressure column in Track panel.

- Using UML (Unified Modeling Language) notation, Sonia Otero produced the class diagrams for the entire QC and Analysis subsystems. Very useful in terms of internal documentation among developers. Activity diagrams need to be produced as well, to describe how both subsystems behave and interact given users' choices. This work is also part of Sonia Otero's master thesis at FIU.

- The H*Wind-HRD database server hardware platform was upgraded (leveraged NESDIS funds in support of FEMA's HAZUS model). The old DB server became the new H*Wind-HRD application server located at NHC, and the old application server became a development workstation at HRD. Operating systems on these machines were also updated.

- We are updating the H*Wind instructions to be more applicable to NHC Forecasters. The old instructions focused primarily on use of H*Wind from AOML. We will also include documentation on our procedure for estimating surface winds from 700 mb recon data.

- There are currently two user-selectable flight-level wind adjustment methods in H*Wind. If NHC desires additional wind reduction factors, we will need the use cases, documentation, and any code needed to implement them.

- Storm track automation, auto synoptic times, floating 6h default window:

Synoptic times will be automatically extrapolated in H*Wind, the end time auto adjusted to within 30 min ahead of current time, start time 6 h earlier than this. We will also make improvements to storm track file storage so it is less sensitive to the type of fix selected for the start of the time window.

- We have contributed to discussions on the new ATCF formats. Once a final format consensus is reached we will recode our ATCF file generation.

-H*Wind was designed from the beginning as a global tropical cyclone wind field monitoring tool. We have had informal discussions for the past couple of years with JTWC about trying out H*Wind. In December, Shirley Murillo (an HRD meteorologist currently on training at University of Hawaii) was able to run H*Wind at UH via JAVA Web Start. At the end of her training period in late May she will be visiting JTWC to assist with installation of H*Wind via Java Web Start, and to informally train a couple of users to help evaluate H*Wind's operational potential for the Pacific and Indian Ocean basins. In addition, Sam Houston, a former HRD scientist who helped to develop H*Wind, is now a forecaster at the Central Pacific Hurricane Center and has offered to help evaluate H*Wind for potential CPHC use.

- Derived Product application (Interface to create wind swaths, single location time

series, divergence, vorticity products from one or more analyses). Student Stephanie Bergman, an Ohio State graduate student visiting this summer, will help integrate certain components into H*Wind, first Qscat dealias, then possibly this. This is supported by our NESDIS/HAZUS project.

- Convert objective analyses to a 5-mesh analysis to enclose all cases. This and an updated swath application (part of our NESDIS project to help support FEMA's HAZUS estimates of damage after a U. S. hurricane landfall) are currently scheduled for completion by the middle of March.

- Jason Dunion is committed to test H*Wind before season starts in order to prevent mid-season changes.

- "Live" global storm map: a map with an icon representing an active storm on the global map. This will be implemented late in the cycle after satisfying the third round of user-requested improvements and is part of a parallel project (supported by NOAA's High Performance Computing and Communications Program) to develop a web based version of H*Wind.

3. H*Wind JHT Project Time line (Year 1)

1. Train first specialist with existing system (1 August).

2. Evaluate current system against 20-minute timeliness goal (16 August).

3. Train second specialist with existing system (31 August).

4. Specialists provide feedback, suggest enhancements based on 10-15 real- time or retrospective analyses (31 October).

5. 1st quarter progress report (1 November).

6. 2nd quarter progress report (1 February 02)

7. Develop software upgrades (1 April 02).

a) Currently-known requirements

1. Complete analysis database storage procedures (1 August)

2. Automate observation database updates (15 August)

3. Automate storm track (15 August)

4. Identify data bottlenecks (31 August)

5. Implement background field (31 August)

6. Identify user-defined reduction algorithms (31 August)

7. Optimize data flow (1 February 02)

8. Implement user-defined reduction algorithms (1 March 02)

9. Generate and implement N-AWIPS-compatible format for display (1 Apr 02)

10. Implement automatic annotations (1 June 02)

11. Develop ATCF message (1 June 02)

b) Specialist-provided suggestions

8. Re-evaluation of product utility (1 May 02).

9. 3rd quarter progress report (1 May 02).

10. Second iteration upgrades (if necessary) (1 July 02).

11. 4th quarter progress report (1 August 02).

4. Proposed Year 2 Project

A. Work Plan

The second year of this project will focus on training, operational testing by NHC staff, implementation of user-recommended software changes, and performance enhancements. The balance of NHC hurricane specialists and any other personnel identified by NHC will be trained during and we will work with NHC to identify required improvements based on operational user feedback. Following the 2002 hurricane season we will work with NHC to see how to best integrate H*Wind into the forecast and warning cycle work flow and product suite. Prioritized, user-requested improvement suggestions will then be implemented for the final version of H*Wind in time for the 2003 hurricane season. NHC infrastructure procurements, installation, and training, for H*Wind will take place during the spring of 2003 and final testing and bug fixes of H*Wind will take place during the first two months of the 2003 season. We expect to declare H*Wind operational by August 2003.

We cannot emphasize enough that this effort requires participation and cooperation from both sides. H*Wind has the capability of helping forecasters examine and visualize one of the most important aspects of their forecasts...an objective estimate of the magnitude and extent of the wind field including all wind radii and the peak winds. We are making numerous improvements to minimize forecaster involvement with anything time consuming but they will still need to occasionally interact with the observations and conduct analyses on a regular basis. Hurricane specialists may need to change work habits to find a way to make H*Wind a part of their regular work flow. If there is currently no time in the forecaster's work flow to accommodate such activities, (it will only get worse as additional new JHT technology is delivered) the work flow should be re-examined in detail to see how to best incorporate new technology and eliminate outdated tasks and products.

B. Performance Optimization

Besides integrating H*Wind into the operational work flow, there are also issues related to H*Wind products. HRD has developed analysis products on a regular schedule that are displayed on our web site (http://www.aoml.noaa.gov/hrd/Storm_pages/wind.html). Interactions with users of this information have made it clear that these type of products are desired by the emergency management community, the local forecast offices, and the general public. There are a couple of potential stumbling blocks in releasing them as official products (namely variations from one analysis to another due to new observations or how a user performed quality control on the observations, and uncertainty dependent on the type of inner core observations available). These variations are to be expected; objective wind analyses could still be released as products given proper qualification. Once H*Wind becomes a part of the operational flow at NHC, we believe that the forecasters will become cognizant of the advantages of interacting with the observations to create an objective analysis of the current state of the hurricane wind field that can be shared with the public. We encourage operational participants to be open-minded about the potential of new technology to create new products for new groups of users.

H*Wind's development team has continued to identify other areas of improvement besides those already identified, which we consider are imperative to achieve better performance. These are:

a) Limit database observation queries to within 10 degrees of chosen storm center.

Currently, database observation queries involve retrieving observations for a whole basin. Thanks to the analysis size visualization capabilities, it has been observed and concluded that only observations comprised within the region limited by the outermost analysis mesh make up the actual quality control set and analysis.

In the case the user has entered a track, we will retrieve observations located within a certain region (whose potential maximum size can be discussed) from the track center, and thus, greatly increasing the application's response time by focusing on the real area of interest.

b) Combine queries of surface data and above-surface data into a single database table versus several ones as it stands at the present time (users expect both types of data available during quality control).

c) Efficient retrieval of quality control sets (QCSets).

The above changes require the following tasks:

1) The creation of a testing database using all data from our existing production database on chac (our workstation located at NHC). This step involves:

1.1) Installation of Oracle software on another host and

1.2) Migrate chac (NHC database server) data to the testing host.

Software required for this effort is leveraged by support from the NOAA ESDIM

program. At the present time, migrating Oracle8i data from Solaris to Oracle9i Linux has been very difficult. Some major hurdles: Per our observations, Oracle9i software for Linux is very buggy. Attempts to migrate Oracle8i data from Solaris to Oracle9i Linux have been unsuccessful. Several options are under investigation and we expect to find a solution within the next few months.

2) A complete database reorganization: After a couple of years experience now working with the database we have identified many improvements that will improve performance. This will be the first complete reorganization of our database since its inception three years ago. Addition of new database tables, additional columns to existing tables, design and implementation of PL/SQL scripts to migrate data from old tables to updated ones.

3) A complete rewrite of all PL/SQL packages and SQLJ components (approximately ~6000 lines of code need to be rewritten) to accommodate the database reorganization and provide the necessary query mechanisms to fulfill query requirements as stated in (a). Tasks 1 & 2 cannot be done without a complete testing database.

Note, that the above changes are clearly needed for performance optimization and do NOT diminish H*Wind capabilities to fulfill, somewhat efficiently, JHT requirements. These changes will be made during the second year of the project.

C. NHC Infrastructure Requirements

As discussed in our original proposal to the JHT in May 2001 (http://storm.aoml.noaa.gov/Overview/2001AnalysisSystemProposal.html), we are only requesting funding to assist with additional user training and feedback, and to produce improvements to the software and database technology necessary to transfer H*Wind to operations at NHC. Separate HRD or leveraged funds from other projects (http://storm.aoml.noaa.gov/Proposals.html) currently fund the hardware and database software we have in place at NHC and much of the labor costs associated with H*Wind. At the end of the 2 year period, NHC will be required to budget NWS funds for operational hardware, software, JAVA and IT DB administrator training, and 24/7 operational maintenance and support. A preliminary estimate of the required TPC investment is $45K for two Solaris servers, $25K for Oracle database software (Single Host 8 simultaneous users and support), and ~ $15-20K for JAVA programming and Oracle database administration training course tuition at $ 3,000/course for existing personnel. NHC will be responsible for the system administration (operating system installation, software updates, security patches, backups, etc.) of the 2 Solaris servers. With support from JHT or NHC for follow on years, HRD could continue to develop improved versions of H*Wind. HRD will provide limited database specialist support to assist with transferring the H*Wind software and database to NHC, and to assist with installation and database schema design.

D. Year 2 Time Line

1. Train remaining specialists with enhanced HRD H*Wind system (June-Oct 02).

2. Specialists provide feedback, suggest enhancements based on their own real-time or retrospective analyses (Nov. 02).

3. Complete additional (final) software upgrades (March 03).

4. NHC procure needed h/w, s/w (April 03)

5. Assist NHC with database setup on NHC hardware, transfer LDM scripts, data procedures, H*Wind executables (May 03)

6. Operational tests of NHC H*Wind system (June, July 03)

7. Declare H*Wind/NHC operational (Aug. 03)

E. Budget

Please note: this budget does not include NHC investments needed for H*Wind to be operational at NHC (see NHC Infrastructure Requirements above).

Year 2 Requested Resources

CIMAS Labor $116.5k (DB Specialist 50%, 1 FT programmer, 2 PT programmers 50%)

CIMAS fringe benefits and OH $64k

NOAA labor $17k (Physicist, 20%)

NOAA fringe benefits and overhead $14.3k

Total labor and benefits: $211.8 k

HRD (or other program) Contributions

HRD scientist labor (PI 30% and 3 meteorologists 25%) (~$65k)

Fringe benefits $13.6 k

Overhead $40.9k

Total NOAA HRD labor, OH and benefits $119.5k

programmer training $13k

travel $8k

software $10 k

hardware $25k

Total HRD and other program contributions: $200.5K

5. APPENDIX Please see our first quarter progress report on the web at:
http://storm.aoml.noaa.gov/Reports/JHTProgressReport1162002.html